AF/2624
IFW

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Robert D. Barnes et al.	§	Group Art Unit:	2624
Serial No.: 09/448,940	§		
Filed: November 24, 1999	§	Examiner:	Do, Anh Hong
For: IMAGE DATA COMPRESSION EMPLOYING MULTIPLE COMPRESSION CODE TABLES	§	Atty. Docket:	GEMS:0071/YOD 15-IS-5393

Mail Stop Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

CERTIFICATE OF MAILING
37 C.F.R. 1.8

I hereby certify that this correspondence is being deposited with the U.S. Postal Service with sufficient postage as First Class Mail in an envelope addressed to: Commissioner for Patents, Mail Stop Appeal Brief-Patents, P.O. Box 1450,Alexandria, VA 22313-1450, on the date below:

November 7, 2005
Date

Patrick S. Yoder

APPEAL BRIEF PURSUANT TO 37 C.F.R. §§ 41.31 AND 41.37

This Appeal Brief is being filed in furtherance to the Notice of Appeal mailed on August 25, 2005, and received by the Patent Office on September 6, 2005.

The Commissioner is authorized to charge the requisite fee of $500.00, and any additional fees which may be necessary to advance prosecution of the present application, to Account No. 50-2401, Order No. 15IS5393-1/YOD (GEMS:0071).

11/14/2005 NNGUYEN1 00000058 502401 09448940
01 FC:1402 500.00 DA

1. REAL PARTY IN INTEREST

The real party in interest is General Electric Company, the Assignee of the above-referenced application by virtue of the Assignment recorded at reel 010421, frame 0753, and recorded on November 24, 1999. General Electric Company, as Assignee, will be directly affected by the Board's decision in the pending appeal.

2. RELATED APPEALS AND INTERFERENCES

Appellants are unaware of any other appeals or interferences related to this Appeal. The undersigned is Appellants' legal representative in this Appeal.

3. STATUS OF CLAIMS

Claims 1-27 are currently pending and currently under final rejection and, thus, are the subject of this appeal.

4. STATUS OF AMENDMENTS

The Appellants have not submitted any amendments subsequent to the Final Office Action mailed on July 21, 2005.

5. SUMMARY OF CLAIMED SUBJECT MATTER

The present invention relates generally to a field of image compression and decompression. *See* Application, page 1, lines 5-6. More particularly the invention relates to a technique for rapidly and optimally compressing and decompressing image data through the use of one or more compression code tables selected from a family of predefined tables. *See id.* at page 1, lines 6-8.

The Application contains four independent claims, namely, claims 1, 12, 18, and 24, all of which are the subject of this Appeal. The subject matter of these claims is summarized below.

With regard to the aspect of the invention set forth in independent claim 1, discussions of the recited features of claim 1 can be found at least in the below cited locations of the specification and drawings. By way of example, an embodiment in accordance with claim 1 provides a method for compressing image data (e.g., 296) from an uncompressed image data stream. *See, e.g., id.* at page 8, lines 4-10; *see also* Fig. 6. The method comprises compiling and storing compression mapping tables (e.g., 170) for converting uncompressed data to lossless compressed data. *See, e.g., id.* at page 6, lines 3-8; page 14, lines 25-27; *see also* Fig. 7. The method further comprises applying (e.g., 286) at least first and second compression mapping tables to subregions of an uncompressed image data stream to compress the subregions. *See, e.g., id.* at page 18, lines 18-28; page 19, lines 15-19 and 26-29; *see also* Fig. 6. Further, the method comprises appending data for the compressed subregions to form compressed image data stream. *See id.* at page 19, lines 30-33.

With regard to the aspect of the invention set forth in independent claim 12, discussions of the recited features of claim 12 can be found at least in the below cited locations of the specification and drawings. By way of example, an embodiment in accordance with claim 12 provides a method for compressing image data, comprising defining a family of compression code tables (e.g., 170) for converting uncompressed image data to lossless compressed data. *See, e.g., id.* at page 8, lines 4-10; page 14, lines 25-27; *see also* Fig. 7. Further, the method comprises storing the compression code tables (e.g., 32) in an image data compression station and in an image data decompression station. *See, e.g., id.* at page 6, lines 3-8; *see also* Fig. 1. Further, the method comprises selecting at least two of the compression code tables for compression of subregions of an image data stream. *See, e.g., id.* at page 17, line 30-page 18, line 3. The method further comprises compressing the image data stream (e.g., 296) in accordance with the selected compression code (e.g., 170) tables at the compression station and for decompression at the decompression station (e.g., 32). *See, e.g., id.* at page 6, lines 5-8; *see also* Figs. 1, 6, and 7.

With regard to the aspect of the invention set forth in independent claim 18, discussions of the recited features of claim 18 can be found at least in the below cited locations of the specification and drawings. By way of example, an embodiment in accordance with claim 18 provides a system for storing, transmitting and viewing images, comprising a data compression station (e.g., 22) configured to store compression code tables and execute compression routines. *See, e.g., id.* at page 5, lines 1-4; page 6, lines 3-8; *see also* Fig. 1. Further, the compression station converts an image data stream to a compressed file by dividing it into subregions (e.g., 274, 284) that are compressed in accordance with compression code tables (e.g., 170) that provide optimal lossless compression of the subregion. *See, e.g., id.* at page 8, lines 4-9; *see also* Figs. 6 and 7. Further, the system comprises a data storage device (e.g., 30) for receiving and storing the compressed file, and an image decompression station configured to store the compression tables (e.g., 32), to access the compressed file from the data storage device (e.g., 20) and to execute a decompression routine using compression code tables (e.g., 170) to compress the image data and to decompress the compressed data. *See, e.g., id.* at page 6, lines 4-19; *see also* Figs. 1 and 7.

With regard to the aspect of the invention set forth in independent claim 24, discussions of the recited features of claim 24 can be found at least in the below cited locations of the specification and drawings. By way of example, an embodiment in accordance with claim 24 provides a computer program for compressing image data, comprising a machine readable medium (e.g., 32), configuration code, and compression code tables (e.g., 170) stored on the machine readable medium. *See, e.g., id.* Figs. 1 and 7. The configuration code includes an algorithm for analyzing an image data stream for compressing subregions (e.g., 296) by application of compression code tables (e.g., 170), and for compiling the compressed subregions into a lossless compressed data file. *See, e.g., id.* at page 8, lines 4-9; *see also* Figs. 6, and 7.

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Appellants respectfully urge the Board to review and reverse the Examiner's sole ground of rejection in which the Examiner rejected claims 1-27 under 35 U.S.C. § 103(a) as being rendered obvious by U.S. Patent No. 5,936, 616 to Balkanski et al. ("Balkanski") in view of EP No. 0974933 to Konstantinides et al. ("Konstantinides").

7. ARGUMENT

As discussed in detail below, the Examiner has improperly rejected the pending claims. Further, the Examiner has misapplied long-standing and binding legal precedents and principles in rejecting the claims under Section 103. Accordingly, Appellants respectfully request full and favorable consideration by the Board, as Appellants strongly believe that claims 1-27 are currently in condition for allowance.

A. Ground of Rejection.

The Examiner rejected claims 1-27 on the sole ground of obviousness in view of Balkanski and Konstantinides. Appellants respectfully traverse this rejection.

1. Judicial precedent has clearly established a legal standard for a *prima facie* obviousness rejection.

The burden of establishing a *prima facie* case of obviousness falls on the Examiner. *Ex parte Wolters and Kuypers*, 214 U.S.P.Q. 735 (B.P.A.I. 1979). Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention absent some teaching or suggestion supporting the combination. *ACS Hospital Systems, Inc. v. Montefiore Hospital*, 732 F.2d 1572, 1577, 221 U.S.P.Q. 929, 933 (Fed. Cir. 1984). Accordingly, to establish a *prima facie* case, the Examiner must not only show that the combination includes all of the claimed elements, but also a convincing line of reason as to why one of ordinary skill in the art would have found the claimed invention to have been obvious in light of the teachings of the references. *Ex parte Clapp*, 227 U.S.P.Q. 972 (B.P.A.I. 1985). When prior art references require a selected combination to render obvious a subsequent invention, there must be some

reason for the combination other than the hindsight gained from the invention itself, i.e., something in the prior art as a whole must suggest the desirability, and thus the obviousness, of making the combination. *Uniroyal Inc. v. Rudkin-Wiley Corp.*, 837 F.2d 1044, 5 U.S.P.Q.2d 1434 (Fed. Cir. 1988).

2. **The Examiner's rejection of independent claim 1, 12, 18, and 24 is improper because the rejection fails to establish a *prima facie* case of obviousness.**

Independent claim 1 recites:

> A method for compressing image data from an uncompressed image data stream, the method comprising the steps of:
> (a) compiling and storing a plurality of compression mapping tables for converting uncompressed data representative of individual picture elements *to lossless compressed data*;
> (b) applying at least first and second compression mapping tables from the stored plurality of compression mapping tables to subregions of an uncompressed image data stream to compress the subregions; and
> (c) appending data for the compressed subregions to form a compressed image data stream. (Emphasis added.)

Independent claim 12 recites:

> A method for compressing image data, the method comprising the step of:
> (a) defining a family of compression code tables for converting uncompressed image data *to lossless compressed data*;
> (b) storing the compression code tables in an image data compression station and in an image data decompression station;
> (c) selecting at least two of the compression code tables for compression of subregions of an image data stream;
> (d) compressing the image data stream in accordance with the selected compression

> code tables at the compression station for decompression at the decompression station. (Emphasis added.)

Independent claim 18 recites:

> A system for storing, transmitting and viewing images, the system comprising:
>
> a data compression station configured to store a plurality of compression code tables for conversion of image data *to lossless compressed image data* and to execute a compression routine in which an image data stream is converted to a compressed file by dividing into subregions and each subregion compressing in accordance with a compression code table selected from the plurality of compression code tables based upon which compression code table provides *optimal lossless compression* of the subregion;
>
> a data storage device for receiving and storing the compressed file; and
>
> an image decompression station configured to store the plurality of compression code tables, to access the compressed file from the data storage device, and to execute a decompression routine in which the compression code tables applied to compress the image data stream are applied to decompress the compressed file to reconstruct the image data stream. (Emphasis added.)

Independent claim 24 recites:

> A computer program for compressing image data, the program comprising:
>
> a machine readable medium; and
>
> configuration code and a plurality of compression code tables stored on the machine readable medium, the configuration code including an algorithm for analyzing an image data stream, for compressing subregions of the image data stream by application of a plurality of compression code tables, and for compiling the compressed

> subregions into *a lossless compressed data file*. (Emphasis added.)

Accordingly, each of the independent claims 1, 12, 18 and 24 includes recitations relating to the compression of image data in a lossless fashion, which is clearly described in the present application. Further, independent claims 1 and 12 include recitations relating to the compression code tables being applied to uncompressed image data.

Because the Examiner rejected independent claims 1, 12, 18, and 24 based on the same cited references, Appellants will discuss the recited features missing from the combination of Balkanski and Konstantinides for each of the independent claims 1, 12, 18, and 24 together. *See* Official Action mailed April 21, 2005, p. 2-10. In the rejection, the Examiner asserted that the recited features of the independent claims 1, 12, 18, and 24 are disclosed by the combination of Balkanski and Konstantinides. However, the Examiner's rejection fails for at least two reasons. First, Balkanski and Konstantinides fail to disclose lossless compression of image data, which is clearly recited in the independent claims 1, 12, 18, and 24. Secondly, Balkanski and Konstantinides fail to disclose applying the compression code tables to uncompressed image data, which is clearly recited in the independent claims 1 and 12. Hence, Balkanski and Konstantinides do not render the claimed subject matter obvious, as discussed below.

B. <u>The References Fail To Teach Lossless Compression As Claimed.</u>

1. <u>The claims relate to lossless image data compression.</u>

In the present application, Appellants describe a technique for rapidly and optimally compressing and decompressing image data through the use of one or more compression code tables selected from a family of predefined tables. *See* Application, page 1, lines 5-8. Because the image files may be stored in raw and processed formats, many image files are quite large and consume considerable memory space. *See* Application, page 1, lines 11-30. Accordingly, the present application describes a technique for image data compression that analyzes the image data stream by subregions

to identify the compression code table that provides the optimal compression for each subregion. *See* Application, page 3, lines 8-17. By utilizing the compression code tables, the image may be later regenerated to the original image data in a lossless fashion. *See* Application, page 20, line 31-page 21, line 3. As such, the application clearly describes the compression of image data in a lossless fashion, and further describes applying the compression code tables to uncompressed image data.

Lossless image compression is important in certain contexts. For example, unlike many typical web and media applications, medical imaging often requires highly detailed and accurate reproduceable images. No loss of information or detail is permitted. Thus, rounding errors, truncation, quantization, and so forth are typically to be avoided. The claimed lossless compression targets such applications.

2. **Any process that employs quantization is necessarily lossy, not lossless.**

As a preliminary matter, Appellants note that the use of quantization is, by definition, a lossy compression process. Quantization clearly compresses an image by reducing the bits associated with the image through a many-to-one mapping. Once quantized, the image may not be recreated into the original image because the quantization drops bits from the image, which cannot be recovered. As one skilled in the art would recognize, the quantization of the image results in a lossy compression process, as illustrated by the definitions that are provided in the attached Appendix of Evidence. Specifically, the Appendix A includes three pages of definitions regarding various compression techniques found at the URL: http://my.engr.ucdavis.edu/~ssaha/glossary.html. This evidence was previously presented to the Examiner. However, because the URL may no longer present the same information, Appellants again submit a printout in the Appendix to this Brief for the convenience of the Board, and to reflect the understanding of one skilled in the art.

3. **Balkanski teaches lossy, not lossless, compression.**

In contrast to the claimed subject matter, Balkanski teaches a technique for compressing data to reduce the amount of data through a lossy compression process. *See* Balkanski, col. 1, lines 18-21. Balkanski describes lossless image compression as compressing an image with data that may be mathematically restored to the original image, while lossy image compression does not preserve all the information and can not be restored to the original image. *See* Balkanski, col. 2, lines 52-58.

Accordingly, the Balkanski system describes a data compression process that utilizes a quantizer unit 108 to minimize the bits utilized to display an image. *See* Balkanski, Fig. 1; col. 9, lines 4-25. In particular, the quantizer unit 108 discards bits, such as the 6 most significant bits and the 15 least significant bits, to provide greater compression of the image, which is a lossy compression process. *See* Balkanski, col. 9, lines 25-32. After the image has been quantized, Balkanski describes further compressing the image by applying Huffman code tables 117 that are accessed by a coder unit 111a during compression and by a decoder unit 111b during decompression. *See* Balkanski, col. 10, lines 13-18. As a result, the Huffman code tables 117 are utilized to further compress data that has been processed (i.e. compressed) by the quantizer unit 108. The overall process is, then necessarily lossy, not lossless.

4. **Konstantinides teaches lossy, not lossless, compression.**

Similarly, Konstantinides provides a simple metric for picture and text segments design to allow the text to be compressed at better ratios than pictures. *See* Konstantinides, page 3, paragraph 0015. In the Konstantinides system, a discrete cosine transformer 14 is coupled to a quantizer 18 and variable quantization subsystem 54 that includes a quantizer 58. *See* Konstantinides, Fig. 2; page 3, paragraphs 0022 and 0023; page 4, paragraph 0034. The quantizers 18 and 58 are specifically described as being coupled to quantization tables 16 that contain lossy quantization factors. *See* Konstantinides, page 3, paragraph 0023. After the image has been quantized, the Konstantinides system further compresses the quantized image in an entropy encoder 20

with Huffman tables 22. *See* Konstantinides, page 4, paragraph 0037. As a result, the entropy encoder 20 is further compressing quantized image data that has been compressed by the quantizer 18 and 58. Again, this overall process is necessarily lossy, not lossless.

In the Response to Argument section of the Final Office Action mailed on April 21, 2005, the Examiner stated, in a cursory analysis of Konstantinides, that the reference "cures the deficiency" of Balkanski by teaching run-length encoding. The passage referred to by the Examiner actually reads:

> *After quantization*, the quantized discrete cosine transformer 14 output is rearranged in raster, or zigzag, order and is compressed using run-length encoding which is a lossless, entropy encoding using Huffman tables 22 in the entropy encoder.
>
> Konstantinides, page 4, lines 44-46 (emphasis added.)

Although Konstantinides discloses a process that utilizes in part a lossless entropy encoder, the reference must be considered in its entirety. Further, the reference discloses a process utilizing a quantizer 18 employing lossy quantization factors from a quantization table 16. *See* Fig. 3. The use of quantization in a data compression process necessarily implies the process, in this case the overall process, is lossy. Accordingly, the process disclosed by the reference, considered as a whole, is undoubtedly a lossy process. The Examiner is reminded that it is improper to select a part of the teachings of any reference while discounting or ignoring others.

5. <u>Any combination of Balkanski and Konstantinides would necessarily include lossy, not lossless, compression.</u>

In the teachings of Balkanski and Konstantinides, lossy and lossless compression are clearly defined. For instance, in Balkanski, lossy compression is described as not preserving all of the information about an image, while lossless compression allows the exact mathematical restoration of the image data. *See* Balkanski, col. 2, lines 51-59. Similarly, in Konstantinides, lossy compression is described as discarding as much of the

image as possible without significantly affecting the appearance of the image, while lossless is achieved without discarding any of the image data. *See* Konstantinides, page 2, paragraph 0003. Accordingly, any reference that describes quantization of an image is utilizing a lossy compression process.

Both Balkanski and Konstantinides fail to disclose lossless compression of image data, which is clearly recited in the independent claims 1, 12, 18, and 24. Thus, any combination of their teaching would necessarily imply lossy compression. The references, even in combination, cannot support a *prima facie* case of obviousness.

C. **The References Fail To Teach Code Tables Applied To Uncompressed Image Data As Recited In Claims 1 And 12.**

1. **Neither Balkanski nor Konstantinides teach applying compression code tables to uncompressed image data.**

In the rejection, the Examiner asserted that the recited features of the independent claims 1, 12, 18, and 24 are disclosed by the combination of Balkanski and Konstantinides. Specifically, the Examiner relied upon Balkanski to disclose all of the claimed subject matter, but admitted that Balkanski does not expressly teach lossless compression. In an attempt to cure this deficiency, the Examiner asserted that Konstantinides discloses an "entropy encoder 20 using Huffman tables 22 for converting uncompressed image data representative of individual picture elements from quantizer 18 into lossless compressed image data." However, as noted above, neither Balkanski nor Konstantinides disclose or teach lossless compression of image data or applying the compression code tables to uncompressed image data.

2. **Teachings of Balkanski.**

With regard to Balkanski, the quantizer unit 108 of Balkanski selects one of four tables, which relate to different compression ratios, to compress the image data by discarding bits. *See* Balkanski, col. 9, lines 25-32; col. 18, lines 1-18. Because the coder unit 111a translates the data after the quantizer unit 108, the image data has already been

compressed before the Huffman code tables 117 are applied. As a result, the Huffman code tables 117 are applied by the coder unit 111a after the data has been compressed. Clearly, the Huffman code tables 117 are not applied to uncompressed data, much less uncompressed image data representative of individual picture elements. Accordingly, Balkanski fails to disclose or teach applying the compression code tables to uncompressed image data.

3. **The teachings of Konstantinides.**

Furthermore, with regard to Konstantinides, quantizer 18 and quantizer 58 compress all of the image data that is provided to the entropy encoder 20. That is, the entropy encoder 20 receives quantized image data, which is compressed image data from quantizer 18 and quantizer 58. Only after the image has been quantized does the entropy encoder 20 further compress the quantized image data with Huffman tables 22. *See* Konstantinides, page 4, paragraph 0037. As a result, the entropy encoder 20 applies the Huffman tables 22 after the data has been compressed. Because Konstantinides clearly discloses using the entropy encoder 20 after quantization, it cannot teach or disclose a applying the compression code tables to uncompressed image data.

4. **The combined teachings.**

Accordingly, Balkanski and Konstantinides, together, fail to teach this recitation, and thus, do not render obvious the subject matter of independent claims 1 and 12.The references, therefore, fail to establish *a prima facie* case of obviousness of claims 1 or 12, or their dependent claims.

Respectfully submitted,

Date: November 7, 2005

Patrick S. Yoder
Reg. No. 37,479
FLETCHER YODER
P.O. Box 692289
Houston, TX 77269-2289
(281) 970-4545

8. APPENDIX OF CLAIMS ON APPEAL

Listing of Claims:

1. (previously presented) A method for compressing image data from an uncompressed image data stream, the method comprising the steps of:

(a) compiling and storing a plurality of compression mapping tables for converting uncompressed data representative of individual picture elements to lossless compressed data;

(b) applying at least first and second compression mapping tables from the stored plurality of compression mapping tables to subregions of an uncompressed image data stream to compress the subregions; and

(c) appending data for the compressed subregions to form a compressed image data stream.

2. (original) The method of claim 1, wherein the compression mapping tables are compression tables mapping a parameter representative of each picture element to a compressed data code.

3. (original) The method of claim 2, wherein the parameter is a prediction error for each picture element.

4. (original) The method of claim 3, wherein the prediction errors are identified by application of a desired predictor algorithm to the uncompressed image data stream.

5. (original) The method of claim 1, including the further step of selecting the compression mapping tables applied in step (b) from the plurality of compression mapping tables.

6. (original) The method of claim 5, wherein the compression mapping tables are selected based upon relative entropy levels of each subregion.

7. (original) The method of claim 6, wherein the relative entropy levels are determined by analysis of relative variation of picture element intensity within each subregion.

8. (original) The method of claim 7, wherein the variation of picture element intensity is determined by application of a prediction algorithm to determine a difference between a predicted value of each picture element and the actual value of the respective picture element.

9. (original) The method of claim 1, wherein the compression mapping tables employed in step (b) are selected based upon which compression mapping tables provide the shortest compressed data stream for each subregion.

10. (original) The method of claim 1, wherein the number of compression mapping tables employed in step (b) may be encoded with at most two bits of data.

11. (original) The method of claim 1, including the step of encoding in the compressed image data stream identifiers representative of the compression mapping tables applied in step (b).

12. (previously presented) A method for compressing image data, the method comprising the step of:

(a) defining a family of compression code tables for converting uncompressed image data to lossless compressed data;

(b) storing the compression code tables in an image data compression station and in an image data decompression station;

(c) selecting at least two of the compression code tables for compression of subregions of an image data stream;

(d) compressing the image data stream in accordance with the selected compression code tables at the compression station for decompression at the decompression station.

13. (original) The method of claim 12, including the step of encoding in the compressed image data stream identifiers of the selected compression code tables.

14. (original) The method of claim 12, wherein the compression code tables are defined based upon analysis of typical images to be compressed at the compression station.

15. (original) The method of claim 12, comprising the further step of applying a prediction algorithm to portions of the data stream representative of individual picture elements of an image to determine difference values between predicted values and actual values for the picture elements, and wherein the compression code tables are applied to encode the difference values.

16. (original) The method of claim 12, wherein the compression code tables selected at step (c) are selected based upon which tables of the family of tables provides the shortest stream of compressed data for each subregion.

17. (original) The method of claim 12, wherein the number of compression mapping tables employed in step (c) may be encoded with at most two bits of data.

18. (previously presented) A system for storing, transmitting and viewing images, the system comprising:

a data compression station configured to store a plurality of compression code tables for conversion of image data to lossless compressed image data and to execute a

compression routine in which an image data stream is converted to a compressed file by dividing into subregions and each subregion compressing in accordance with a compression code table selected from the plurality of compression code tables based upon which compression code table provides optimal lossless compression of the subregion;

a data storage device for receiving and storing the compressed file; and

an image decompression station configured to store the plurality of compression code tables, to access the compressed file from the data storage device, and to execute a decompression routine in which the compression code tables applied to compress the image data stream are applied to decompress the compressed file to reconstruct the image data stream.

19. (original) The system of claim 18, further comprising a compression library for storing at least a portion of the compression and decompression routines, and wherein the compression station and the decompression station can access the compression library for code used in the compression or decompression routines.

20. (original) The system of claim 18, wherein the compression routine includes analysis of the image data stream for data representative of a characteristic of an image encoded by the image data stream.

21. (original) The system of claim 20, wherein the characteristic is an identification of an image acquisition system originating the image data stream.

22. (original) The system of claim 20, wherein the characteristic is an identification of a feature represented in an image encoded by the image data stream.

23. (original) The system of claim 18, wherein the compression routine includes encoding of identifiers of the selected compression code tables within the compressed file, and wherein the decompression routine includes analysis of the identifiers for selection of the same compression code tables for decompression of the compressed file.

24. (previously presented) A computer program for compressing image data, the program comprising:

a machine readable medium; and

configuration code and a plurality of compression code tables stored on the machine readable medium, the configuration code including an algorithm for analyzing an image data stream, for compressing subregions of the image data stream by application of a plurality of compression code tables, and for compiling the compressed subregions into a lossless compressed data file.

25. (original) The computer program of claim 24, wherein a family of candidate compression code tables is stored on the machine readable medium.

26. (original) The computer program of claim 24, wherein the algorithm includes computation of compressed data lengths provided by application of a plurality of candidate compression code tables for compression of each subregion, and selection of the compression code tables providing the shortest compressed data lengths for each subregion.

27. (original) The computer program of claim 24, wherein the code is installed on the machine readable medium via a configurable network link.

9. APPENDIX OF EVIDENCE

Appellants submit as evidence of the nature of lossless and lossy compression techniques, an explanatory expose previously posted at a website hosted by The University of California, Davis (http://my.engr.ucdavis.edu/~ssaha/glossary.html).

10. APPENDIX OF RELATED PROCEEDINGS

None.

Glossary of Terms: Image Data Compression

ISO - International Organization for Standardization
Founded in 1947, ISO is a worldwide federation of national standards bodies from some 130 countries, one from each country, and has almost 200 technical committees. The mission of ISO is to promote the development of standardization and related activities in the world with a view to facilitating the international exchange of goods and services, and to developing cooperation in the spheres of intellectual, scientific, technological and economic activity. It issues standards on a vast number of subjects, ranging from nuts and bolts to image and video compression systems.

ITU - International Telecommunications Union (formerly **CCITT)**
Formerly known as the Consultative Committee on International Telegraph and Telephones (CCITT), and headquartered in Geneva, Switzerland ITU is an international organization within which governments and the private sector coordinate global telecom networks and services like fax and modems.

IEC - International Electrotechnical Commission
The International Electrotechnical Commission is the international standards and conformity assessment body for all fields of electrotechnology. Founded in 1906, the International Electrotechnical Commission (IEC) is the world organization that prepares and publishes international standards for all electrical, electronic and related technologies. The membership consists of more than 50 participating countries. The IECís mission is to promote, through its members, international cooperation on all questions of electrotechnical standardization and related matters, such as the assessment of conformity to standards, in the fields of electricity, electronics and related technologies.

JPEG - Joint Photographic Experts Group
A highly successful continuous-tone, still-picture coding international standard named after the Joint Photographic Experts Group that developed it. The JPEG standard (IS 10918-1/ITU-T T.81) was originally approved in 1992 and was developed as an official joint project of both the ISO/IEC JTC1 and ITU-T organizations.

JPEG-2000
A future new still-picture coding standard, JPEG-2000 is a joint project of the ITU-T SG8 and ISO/IEC JTC1 SC29 WG1 organizations. It is scheduled for completion late in the year 2000.

MPEG - Motion Pictures Experts Group
A highly successful image-sequence or video coding international standard named after the Motion Pictures Experts Group that developed it. The standard comes in various flavors like MPEG-1, MPEG-2, and MPEG-4 having different features, the main one being the bit rate. The MPEG-1 standard (IS 11172-2) was a project of the ISO/IEC JTC1 organization and was approved in 1993. MPEG-1 codec is capable of approximately videotape quality or better at about 1.5 Mbit/s. MPEG-2 forms the heart of broadcast-quality digital television (DTV). It's a step higher in bit rate, picture quality, and popularity. The MPEG-2 standard (IS 13818-2) was a joint project of the ISO/IEC JTC1 and ITU-T organizations and was completed in 1994. Its

target bit-rate range is approximately 4-30 Mbit/s. MPEG-4 is currently under development.

Lossless and Lossy Image Compression

In lossless compression, the reconstructed image after compression is numerically identical to the original image on a pixel-by-pixel basis. However, only a modest amount of compression is achievable in this technique. In lossy compression, on the other hand, the reconstructed image contains degradation relative to the original, because redundant information is discarded during compression. As a result, much higher compression is achievable, and under normal viewing conditions, no visible loss is perceived (visually lossless).

Predictive and Transform coding

In predictive coding, information already sent or available is used to predict future values, and the difference is coded. Since this is done in the image data or spatial domain, it is relatively simple to implement and is readily adapted to local image characteristics. Differential Pulse Code Modulation (DPCM) is one particular example of predictive coding. Transform coding, on the other hand, first transforms the image from its spatial domain representation to a different type of representation using some well-known transform like DCT and then codes the transformed values (coefficients). This method provides greater data compression compared to predictive methods, although at the expense of greater computations.

DCT - Discrete Cosine Transform

The DCT can be regarded as a discrete-time version of the Fourier-Cosine series. It is a close relative of DFT - a technique for converting a signal into elementary frequency components, and thus DCT can be computed with a Fast Fourier Transform (FFT) like algorithm in *O(n log n)* operations. Unlike DFT, DCT is real-valued and provides a better approximation of a signal with fewer coefficients. The DCT of a discrete signal *x(n), n=0, 1, .. , N-1* is defined as,

$$X(u) = \sqrt{\frac{2}{N}}\, C(u) \sum_{n=0}^{N-1} x(n) \cos\left(\frac{(2n+1)u\pi}{2N}\right)$$

where, $C(u) = 0.707$ for $u = 0$ and
$= 1$ otherwise.

DCT is very popular and used extensively in current image compression algorithms and standard.

DWT - Discrete Wavelet Transform

Wavelets are functions defined over a finite interval and having an average value of zero. The basic idea of wavelet transform is to represent any arbitrary function *É(t)* as a superposition of a set of such wavelets or basis functions. These basis functions or ëbaby waveletsí are obtained from a single prototype wavelet called the ëmother waveletí, by dilations or contractions (scaling) and translations (shifts). The Discrete Wavelet Transform of a finite length signal *x(n)* having *N* components for example, is expressed by an *N* by *N* matrix.

Quantization

Quantization is simply the process of decreasing the number of bits needed to store a set of values (transformed coefficients, in the context of data compression) by reducing the precision of

those values. Since quantization is a many-to-one mapping, it's a lossy process and is the main source of compression in a lossy image coding scheme. Quantization can be performed on each individual coefficient, which is known as *Scalar Quantization (SQ)*. Quantization can also be performed on a group of coefficients together, and this is known as *Vector Quantization (VQ)*. Both, uniform and non-uniform quantizers can be used depending on the problem at hand.

Entropy Encoder

An entropy encoder uses a model to accurately determine the probabilities for each input data value and produces an appropriate code based on these probabilities so that the resultant output code stream will be smaller than the input stream. In image coders an entropy encoder further compresses the quantized/predicted values losslessly to give better overall compression. Most commonly used entropy encoders are the *Huffman encoder* and the *arithmetic encoder,* although for applications requiring fast execution, simple run-length encoding (RLE) has proven very effective.

PSNR - Peak Signal-to-Noise Ratio

This is a quantitative measure of a lossy image coder.

$$\text{PSNR} = 10\log_{10}\left(\frac{P^2}{D}\right) = 10\log_{10}\left(\frac{255}{MSE}\right) \text{ dB, for an 8-bit image.}$$

MSE - Mean Square Error

This is the quantitative measure of error between the original and reconstructed images.

$$\text{MSE} = \frac{1}{MN}\sum_{m=0}^{M-1}\sum_{n=0}^{N-1}| x(m,n) - \hat{x}(m,n)|^2$$